The Importance of Biogenic Emissions for Regional Air Quality Modeling

Thomas E. Pierce*
Atmospheric Modeling Division
National Exposure Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC

Christopher D. Geron
National Risk Management Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC

BACKGROUND

• Biogenic emissions are a widespread and ubiquitous contributor to background air chemistry.

• For regional air quality modeling, EPA-ORD's research on biogenic emissions has focused on characterizing emissions of volatile organic compounds (VOCs) from vegetation and nitric oxides (NOx) from soils.

• Our work seeks to build accurate biogenic emission modeling tools that can be used by decision-makers when simulating ozone and fine particulate matter (PM).

BUILDING THE TOOLS

Two key building blocks of the Biogenic Emission Inventory System (BEIS) are (1) vegetation data and (2) emission factors.

Vegetation data: Using a Geographic Information System (GIS) and national satellite, forest, and agricultural databases, we have created the Biogenic Emissions Landuse Database (BELD). The latest version of this database, BELD3, provides distributions of 230 vegetation classes at a 1 km resolution.

Examples of vegetation data from the Biogenic Emissions Landuse Database

Zea mays (Corn/Maize) — 1 Kilometer Resolution
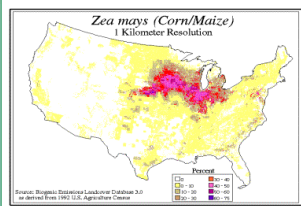
Quercus alba (White Oak) — 1 Kilometer Resolution
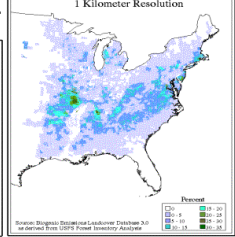
Emission factors: Emission measurements have been assembled into an extensive emission factor database that matches up with the BELD3 vegetation classes. VOC and NOx emissions vary considerably by vegetation type and soil use.
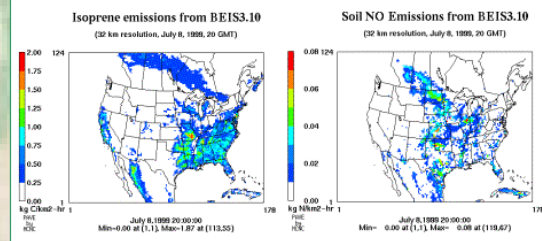
Selected biogenic emission factors from BEIS3

Isoprene (kgC/km^2-hr)*		Soil NO (kgN/km^2-hr)*	
Oak, aspen, eucalyptus …	26.25	Potato …	0.12
Spruce (Englemann) …	21.00	Corn, sorghum …	0.07
Spruce (Norway) …	1.50	Other misc. crops …	0.04
Fir …	0.15	Grassland …	0.03
Pine …	0.07	Forests …	<0.01
Maple …	0.04		
Misc. crops …	0.01	*Normalized to 30 C, bright sunlight	

CONSTRUCTING THE EMISSION INVENTORY

Environmental conditions, such as temperature and solar radiation, strongly influence the rate of emitted biogenic compounds. Using highly-resolved (1 hr/32 km) meteorological data, gridded inventories of isoprene (an important biogenic VOC) and soil NO are developed for regional-scale air quality modeling. Isoprene emission rates respond to vegetation type, temperature, and solar radiation, while soil NO emission rates respond to soil usage, temperature, and soil moisture.
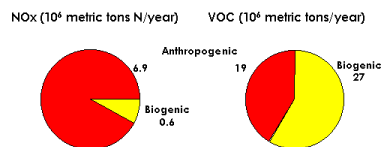

Example of biogenic emissions used in a regional air quality model application

Isoprene emissions from BEIS3.10 (32 km resolution, July 8, 1999, 20 GMT)

Soil NO Emissions from BEIS3.10 (32 km resolution, July 8, 1999, 20 GMT)

## COMPARISONS OF BIOGENIC AND ANTHROPOGENIC EMISSIONS

Although anthropogenic emissions tend to be concentrated in urban areas, biogenic VOC emissions are widespread across forested areas and soil NO emissions are highest over agricultural areas. Estimated biogenic VOC emissions comprise over half of the national annual inventory, while estimated soil NO emissions comprise less than 10% of the national annual inventory.

Comparison of biogenic and anthropogenic emissions estimated across the United States for 1995

NOx (10^6 metric tons N/year) — Anthropogenic 6.9, Biogenic 0.6

VOC (10^6 metric tons/year) — Anthropogenic 19, Biogenic 27

IMPACT ON OZONE MODELING

Over the past decade, decision-makers have included biogenic emissions in air quality simulation modeling. The plots shown below illustrate the influence of biogenic emissions on estimated maximum ozone concentrations for a 2-week period during the summer of 1988.

Maximum ozone simulated for July 28-August 6, 1988
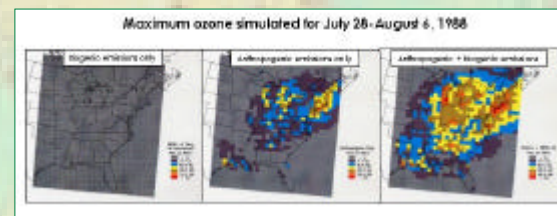
Key findings from this two-week simulation are as follows:

• If only biogenic emissions are considered, modeled ozone concentrations remain near background levels (~40 ppb).

• By adding anthropogenic emissions of VOC and NOx, modeled ozone concentrations exceed the 1-hr National Ambient Air Quality Standard (120 ppb) across much of the eastern United States.

• Despite popular myth, biogenic emissions do not cause ozone problems; they are part of the natural background. It is only after anthropogenic emissions are added to the natural background that harmful levels of ozone result. However, biogenic emissions must be considered when examining anthropogenic emission control strategies.

SELECTED REFERENCES

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Contact: Thomas E. Pierce (Email: pierce.tom@epa.gov)

*On assignment from Air Resources Laboratory, National Oceanic and Atmospheric Administration.

For further information: http://www.epa.gov/asmdnerl/biogen.html

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